10 CSR 20-8.170 Sludge Handling and Disposal.

PURPOSE: The following criteria have been prepared as a guide for the design of sludge handling and disposal facilities. This rule is to be used with rules 10 CSR 20-8.110–10 CSR 20-8.220 for the planning and design of the complete treatment facility. This rule reflects the minimum requirements of the Missouri Clean Water Commission as regards adequacy of design, submission of plans, approval of plans and approval of completed ~~[sewage works]~~ ***wastewater treatment plant****.* ***It is not reasonable or practical to include all aspects of design in these standards. The design engineer should obtain appropriate reference materials which include but are not limited to: copies of design manuals such as Water Environment Federation's Manuals of Practice, the University of Missouri Extension Water Quality Guides 420-449, and other wastewater design manuals containing principles of accepted engineering practice.*** *Deviation from these minimum requirements will be allowed where sufficient documentation is presented to justify the deviation. These criteria ~~[are taken largely from Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, Recommended Standards for Sewage Works and]~~ are based on the best information presently available,* ***including the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.*** *These criteria were originally filed as 10 CSR 20-8.030. It is anticipated that they will be subject to review and revision periodically as additional information and methods appear. Addenda or supplements to this publication will be furnished to consulting engineers and city engineers. If others desire to receive addenda or supplements, please advise the Clean Water Commission so that names can be added to the mailing list.*

Editor's Note: The secretary of state has determined that the publication of this rule in its entirety would be unduly cumbersome or expensive. The entire text of the material referenced has been filed with the secretary of state. This material may be found at the Office of the Secretary of State or at the headquarters of the agency and is available to any interested person at a cost established by state law.

(1) Definitions. Definitions as set forth in the Clean Water Law and 10 CSR 20-2.010 shall apply to those terms when used in this rule, unless the context clearly requires otherwise. Where the terms **"**shall**"** and **"**must**"** are used, they are to mean a mandatory requirement insofar as approval by the *~~[agency]~~* **Missouri Department of Natural Resource (department)** is concerned, unless justification is presented for deviation from the requirements. Other terms, such as **"**should**"**, **"**recommend**"**, **"**preferred**"** and the like, indicate *~~[discretionary requirements on the part of the agency and deviations are subject to individual consideration]~~* **the preference of the department for consideration by the design engineer**.

(A) Deviations. Deviations from these rules may be approved by the department when engineering justification satisfactory to the department is provided. Justification must substantially demonstrate in writing and through calculations that a variation(s) from the design rules will result in either at least equivalent or improved effectiveness. Deviations are subject to case-by-case review with individual project consideration.

(B) 503(b) Regulations. 40 CFR 503 addresses the use and disposal of wastewater sludge generated from the treatment of domestic and municipal wastewater and includes domestic septage. It does not apply to materials such as grease trap residues or other non-domestic wastewater residues pumped from commercial facilities, sludges produced by industrial wastewater treatment facilities, or grit and screenings from publicly owned treatment works (POTWs). 40 CFR 503 establishes two levels of wastewater sludge quality with respect to heavy metal concentrations--pollutant Ceiling Concentrations and Pollutant Concentrations; and two levels of quality with respect to pathogen densities--Class A and Class B; and two types of approaches for meeting vector attraction reduction--wastewater sludge processing or the use of physical barriers.

1. **Class A Biosolids. The Class A designation only applies to the vector attraction reduction requirements. To meet the Class A designation, pathogens (Salmonella sp. bacteria, enteric viruses, and viable helminth ova) in the biosolids are below detectable levels. Class A corresponds to the existing 40 CFR Part 257 "Process to Further Reduce Pathogens (PFRP)" designation.**
2. **Class B.** Biosolids are designated Class B if pathogens are detectable but have been reduced to levels that do not pose a threat to public health and the environment as long as actions are taken to prevent exposure to the biosolids after their use or disposal. When Class B biosolids are land applied, certain restrictions must be met at the application site; other requirements have to be met when Class B biosolids are surface disposed. Class B corresponds to the existing 40 CFR Part 257 "Process to Significantly Reduce Pathogens (PSRP)" designation.

(C) Sludge. Wastewater sludge is the solid, semi-solid, or liquid residue generated during the treatment of domestic wastewater in a treatment works. Sludge includes scum or solids removed in primary, secondary, or advanced wastewater treatment processes and any material derived from wastewater sludge but does not include grit and screenings or ash generated by the firing of wastewater sludge in an incinerator.

(D) Biosolids. Biosolids refers to treated sludge that meets the EPA pollutant and pathogen requirements for land application and surface disposal. Biosolids and sludge are often used interchangeable. Biosolids are organic wastewater solids that can be reused after suitable sludge treatment processes leading to sludge stabilization.

(E) Residuals. Residuals refers to sludges produced from industrial wastewater treatment facilities that undergo treatment for pollutant and pathogen reduction.

Comment [D1]: Alternative definition found in 40 CFR 257→ Sludge means any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect.

(2) **Applicability. This rule shall apply to all wastewater treatment facilities. This rule shall not apply to animal feeding operations, animal manure management systems or other agricultural waste management systems. Design guide and criteria for these facilities are found in 10 CSR 20-8.300.** ~~*[Exceptions. This rule shall not apply to facilities designed for twenty-two thousand five hundred gallons per day (22,500 gpd) (85.4m³) or less (see 10 CSR 20-8.020) for the requirements for those facilities.]*~~

(3) **General** Design Considerations. **Facilities for processing sludge shall be provided at all mechanical wastewater treatment plants. Handling equipment shall be capable of processing sludge to a form suitable for ultimate disposal unless provisions acceptable to the department are made for processing the sludge at an alternate location and identified in the facility plan or summary of design.** ~~*[The selection of sludge handling and disposal methods should include the following considerations: energy requirements; efficacy of sludge thickening; complexity of equipment; staffing requirements; toxic effects of heavy metals and other substances on sludge stabilization and disposal; treatment of side-stream flow such as digester and thickener supernatant; a back-up method of sludge handling and disposal; and methods of ultimate sludge disposal.]*~~

(A) The selection of sludge handling unit processes should be based, at a minimum, upon the following considerations:

1. Local land use;
2. System energy requirements;
3. Cost effectiveness of sludge thickening and dewatering;
4. Equipment complexity and staffing requirements;
5. Adverse effects of heavy metals and other sludge components upon the unit processes;
6. Sludge digestion or stabilization requirements, including appropriate pathogen and vector attraction reduction;
7. Side stream or return flow treatment requirements (e.g., digester or sludge storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows);
8. Sludge storage requirements;
9. Methods of ultimate disposal; and
10. Back-up techniques of sludge handling and disposal.

(B) Industrial Wastes. Consideration shall be given to the type and effects of industrial waste and industrial residuals on the treatment process. It may be necessary to pretreat industrial discharges. Industrial wastes and industrial residuals shall not be discharged to land application system without assessment of the effects the substances may have upon the treatment processor requirements in accordance with state and federal laws.
(C) Sludge Production. The summary of design shall include calculations based on the expected amount of sludge produced or wasted from the wastewater treatment processes. If chemical addition or filtration is included in the process, the dry solids amount from Table X below shall be added to the treatment process value in Table170- X. Following treatment of the sludge, the amount and volume of sludge produced shall decrease and the summary of designs shall include the calculations for the amount of sludge expected based on the sludge treatment technology used; see subsections (5) and (6) for sludge calculation from anaerobic and aerobic digestion.

Table 170-X: Typical Physical Characteristics and Quantities of Sludge Produced based on wastewater treatment technology

Treatment Operation	Specific Gravity of Sludge	Dry Solids Range (lbs/1000 gallons)	Sludge produced dry ton per P.E.
Primary Sedimentation	1.4	0.9-1.4	0.014
Aerated lagoon	1.30	0.7-1.0	0.015
Activated Sludge	1.25	0.6-0.8	0.028
Extended Aeration	1.30	0.7-1.0	0.021
Trickling Filter	1.45	0.5-0.8	0.028
Suspended growth denitrification	1.2	0.1-0.25	0.021
Filtration	1.2	0.1-0.2	
Chemical addition to primary tanks for phosphorus removal	1.9-2.2	2.0-7.0	

(D) Odor Control. Odor control shall be addressed with consideration being given to flexibility of operations and changes of influent sludge characteristics.
(E) Safety. 10 CSR 20-8.140(9).
(F) Chemical Handling, Safety, and Identification. 10 CSR 20-8.140(10)
(G) Division of Environmental Quality Permitting Regulations. The construction permit application shall include documentation that the appropriate permits have been applied for with the Air Pollution Program and/or the Solid Waste Program for sludge handling and treatment processes.

(4) Sludge Thickeners. **Sludge thickeners to reduce the volume of sludge should be considered.** ~~*[As the first step of sludge handling, the need for sludge thickeners to reduce the volume of sludge should be considered.]*~~ The design of thickeners (gravity, dissolved air flotation, centrifuge and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs and the cost of operation. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions. **Centrifuges are discussed in subsection (8) of this rule, Sludge Dewatering.** ~~*[Sludge should be thickened to at least five percent (5%) solids prior to transmission to digesters.]*~~

(A) General.

1. The use of gravity thickening tanks for unstabilized sludges is not recommended because of problems due to septicity unless provisions are made for adequate control of process operational problems and odors at the gravity thickener and any following unit processes.

2. Thickener design shall provide adequate capacity to meet peak demands. Thickeners should be designed to prevent septicity during the thickening process.
3.Duplicate thickeners or alternate storage shall be provided to allow the thickening process to continue without disruption with one unit out of service.
4. Thickeners shall be provided with a means of continuous return of supernatant for treatment. Provisions for side-stream treatment of supernatant should be considered.
5. Consideration should be given to any potential treatment advantages obtained from the blending of sludges from various treatment processes.
6. Mechanical picket arms shall be provided.
7. The drive mechanism shall have:
 A. Sufficient torque capacity to handle the maximum sludge concentration and blanket thickness anticipated; and
 B. A high torque alarm and overload device.
8.Metallic components of gravity thickeners shall be corrosion resistant.

(B) Gravity systems. <u>Secondary</u> clarifiers or gravity thickeners sufficiently sized for clarification will provide for thickening. However, the use of mechanical stirring devices will significantly improve the performance of gravity thickeners. Mechanical thickeners employ low speed stirring mechanisms for continuous mixing and flocculation within the zone of sludge concentration. In this manner, liquid separation is enhanced.
1. Gravity thickeners shall be designed on the basis of the following:
 A. Primary sludge solids loading of twenty to thirty pounds per day per square foot (20-30 lbs/day/ft^2); and
 B. Combined primary and waste activated sludge loading of five to fourteen pounds per day per square foot (5-14 lbs/day/ft^2).
2. Conventional overflow rates for gravity thickeners should be in the range of four hundred to eight hundred gallons per day per square foot (400-800gpd/ft^2). The summary of design shall provide the basis and calculations for the surface loading rates.
3. The side water depth of conventional gravity thickeners shall be a minimum of ten feet (10').
4. Circular thickeners shall have a minimum bottom slope of one and one-half inches per radial foot (1.5"/ft).
5. A gravity sludge thickener shall be so designed as to provide for sludge storage, if sufficient storage is unavailable within other external tankage. Sludge withdrawal from gravity thickeners should be controlled and adjusted, and variable speed pumps should be provided.
6. Gravity thickeners should be provided with bottom scraping equipment to enhance sludge removal. The scraper mechanism peripheral velocity should be in the fifteen to twenty feet per minute range (15-20 ft/min).
 A. The scraper mechanical train shall be capable of withstanding extra heavy torque loads. The normal working torque load shall not exceed ten percent (10%) of the rated torque load.
 B. A method to correct blockage of the scraper mechanism and restore operation from a stalled position should be provided in the Operation and Maintenance Manual.
7. Alternative designs should be based on data obtained from a pilot <u>study</u> in accordance with the requirements of 10 CSR 20-8.140(x)(x). Chemical addition and dilution water feed systems should be evaluated for use to optimize performance.

(C) Dissolved air flotation. Dissolved air flotation (DAF) basins shall be equipped with bottom scrapers to remove settled solids and surface skimmers to remove the float established through release of pressurized air into the sludge inflow. The bottom scraper should function independently of the surface skimmer mechanism. Dissolved air flotation units should be enclosed in a building. A positive air ventilation system and odor control shall be provided.
1. Conventional design parameters include:
 A. Maximum hydraulic loading rates of two gallons per minute per square foot of surface area (2 gal/min/sq. ft.).

B. A solids loading rate in the range of 0.4 to 1.0 pounds per hour per square foot of surface area (lb/hr/sq. ft.) without chemical addition. A solids loading rate of up to 2.5 lbs./hr./sq. ft. may be used if appropriate chemical addition is provided
C. An air supply to sludge solids weight ratio in the range of 0.02 to 0.04.
2. The recycle ratio should be in the thirty percent to one hundred fifty percent (30-150%) range. The recycle pressurization system should utilize DAF effluent or secondary effluent if use of potable water is not available. The retention tank system shall provide a minimum pressure of forty pounds per square inch (40 psig).
3. A polymer feed system shall be provided. The feed system shall meet the requirements of this chapter.
4. Skimmer design shall be multiple or variable speed such as to allow normal operation in the less than one foot per minute (1 fpm) range, with the capability of a speed increase to twenty-five feet per minute (25 fpm).
(D)Mechanical Sludge Thickening.
1. Gravity belt, rotary drum, dissolved air flotation, screw presses, and centrifuges shall be acceptable for mechanical thickening of primary, secondary, and combined sludges.
2. A means of chemically conditioning sludges prior to mechanical thickening shall be provided.
3. Mechanical thickeners should be capable of processing the maximum weekly sludge produced in under thirty-five (35) hours, unless the equipment is designed to be operated unmanned. If the facility operates with multiple shifts or is constantly manned, the summary of design shall include that information and what the processing schedule is.
4. If any period of unmanned operation is anticipated as a normal operating condition, then appropriate instrumentation and fail safe monitoring and alarms shall be provided.
5. Where duplicate units are not provided, a contingency plan shall be submitted with the basis of design. The sludge storage facilities shall be provided that are adequate to store sludge for the period of time anticipated for repairs to be made if the dewatering device is taken out of service for repair.

(5) Anaerobic Sludge Digestion.
(A) General.
1. Multiple units. **Where multiple digesters are not provided, a storage facility or adequate available sludge processing system shall be provided for emergency use so that the digester may be taken out of service without unduly interrupting treatment works operation.** ~~*[Multiple tanks are recommended]*~~ **Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.**. ~~*[Where a single digestion tank is used, an alternate method of sludge processing or emergency storage to maintain continuity of service shall be provided.]*~~
2. Depth. For those units proposed to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor.
A. A minimum sidewater depth of twenty feet (20') ~~*[(6.10 m)]*~~ is recommended.
B. The proportion of depth to diameter should provide for a minimum of six feet (6') storage depth for supernatant liquor, or the proportion of total volume allocated for supernatant should be ten percent (10%) or more.
3. Maintenance provisions. To facilitate draining, cleaning and maintenance, the following features are desirable:
A. Slope. The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of one to twelve (1:12) or greater is recommended. Where the sludge is to be removed by gravity alone, one to four (1:4) slope is recommended.
B. Access manholes. At least two (2) thirty-six inch (36") ~~*[(91 cm)]*~~ diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole shall be provided **that is large enough to permit the use of mechanical equipment to remove grit and sand. The side wall**

access manhole should be low enough to facilitate heavy equipment handling and may be buried in the earthen bank insulation. ~~*[The opening should be large enough to permit the use of mechanical equipment to remove grit and sand.]*~~

C. Safety. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two (2) self-contained breathing units shall be provided for emergency use.

D. Toxic Materials. If the anaerobic digestion process is proposed, the summary of design shall include the wastewater analyses showing the presence or absence of undesirable materials, such as high concentrations of sulfates or inhibitory concentrations of heavy metals.

E. Each digester should have the means for transferring a portion of its contents to other digesters. Multiple digester facilities should have means of returning supernatant from the settling digester unit to appropriate points for treatment.

4. Alarms shall be installed to warn of:

A. Any drop of the liquid level below minimum operating elevation; and

B. Low pressure in the space above the liquid level.

C. Automatic shutdowns should be considered to prevent equipment failure.

(B) Sludge Production. For calculating design sludge handling and disposal needs, sludge production values from a two-stage anaerobic digestion process shall be based on a maximum solids concentration of five percent (5%) without additional thickening. If the basis of sludge production is based on a solids concentration greater than five percent (5%) without thickening, justification shall be included in the summary of design.

1. The solids production values on a dry weight basis shall be based on the following for the listed processes:

A. Primary plus waste activated sludge of at least 0.12 lb/P.E./day; and

B. Primary plus fixed film sludge - at least 0.09 lb/P.E./day.

2.Volatile suspended solids loading should not exceed one hundred pounds per one thousand cubic feet per day (100 lb/1,000 ft^3/ day).

~~*[(B)]*~~ **(C)** Sludge Inlets**, Outlets, and High level overflow.** ~~*[and Outlets.]*~~

1.Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points shall be provided to facilitate flexible operation and effective mixing of the digester contents unless adequate mixing facilities are provided within the digester.

2. Inlet Configurations. One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the two-thirds (2/3) diameter point across the digester.

3. Inlet Discharge Location. Raw sludge inlet discharge points should be so located as to minimize short circuiting to the digested sludge or supernatant draw-offs.

4. Sludge Withdrawal. Sludge withdrawal to disposal should be from the bottom of the tank. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation piping to increase operational flexibility when mixing the tank contents.

5. Emergency Overflow An unvalved vented overflow shall be provided to prevent damage to the digestion tank and cover in case of accidental overfilling. This emergency overflow shall be piped to an appropriate point and at an appropriate rate in the treatment process or sidestream treatment facilities to minimize the impact on process units. ~~*[Multiple recirculation withdrawal and return points should be provided to enhance flexible operation and effective mixing, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank. Raw sludge discharge to the digester should be through the sludge heater and recirculation return piping or directly to the tank if internal mixing facilities are provided. Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation*~~

~~*piping to increase versatility in mixing the tank contents, if the piping is provided. Sludge withdrawal should be at the bottom of the tank.]*~~

~~*[(C)]*~~ **(D)** Tank Capacity. **Where the composition of the wastewater has been established, digester capacity shall be computed from the volume and character of sludge to be digested.**

1. The total digestion tank capacity should be determined by rational calculations**. The calculations shall be submitted in the summary of design to justify the basis of design** and be based upon ~~*[such factors as]*~~

A. volume of sludge added**;**~~*[,]*~~
B. ~~*[its]*~~ **the** percent solids and character**;**~~*[,]*~~
C. the temperature to be maintained in the digesters**;**~~*[,]*~~
D. the degree or extent of mixing to be obtained**;** ~~*[and]*~~
E. the degree of volatile solids reduction required**;**~~*[.]*~~
F. the solids retention time at peak loadings;
G. method of sludge disposal; and
H. the size of the installation with appropriate allowances for gas, scum, supernatant, and digested sludge storage.
I. Secondary digesters of two-stage series digestion systems which are utilized for digested sludge storage and concentration shall not be credited in the calculations for volumes required for sludge digestion.

2. Standard Design. When calculations are not submitted to justify the design based on the above factors, the minimum digestion tank capacity shall be as outlined below. These requirements assume that the raw sludge is derived from ordinary domestic wastewater, a digestion temperature is to be maintained at ninety-five degrees Fahrenheit (95°F) for fifteen (15) days, forty to fifty percent (40%-50%) volatile matter in the digested sludge, and that the digested sludge will be removed frequently from the process. The design detention time for sludge undergoing digestion for stabilization shall be a minimum of fifteen (15) days within the primary digester, but longer periods may be required to achieve the levels of pathogen control and vector attraction reduction necessary for the method used for sludge management.

A. Completely Mixed Systems. For digestion systems providing for intimate and effective mixing of the digester contents, the system may be loaded up to eighty pounds of volatile solids per thousand cubic feet of volume per day (80 lbs/1000($ft^3 \cdot d$)) **or at a volumetric loading that provides fifteen (15) days or more detention time in the active digestion volume** in the active digestion units. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered.

1. Confined mixing systems include arrangements where gas or sludge flows are directed through vertical channels; and mechanical stirring, or pumping systems. Both confined mixing and unconfined continuously discharging gas mixing systems shall be designed to ensure complete turnover of digestion volume every thirty (30) minutes. For tanks over sixty feet (60') in diameter, multiple mixing devices shall be used.

2. Unconfined, sequentially discharging gas mixing systems shall be designed using the number of discharge points and gas flow rates shown for the various tank diameters as listed in this section, unless sufficient operating data is submitted and approved to verify the performance reliability of alternative designs.

3. The minimum gas flow supplied for complete mixing shall be fifteen cubic feet per minute per thousand cubic feet (15 ft^3/min/ 1000 ft^3) of digestion volume. Flow measuring devices and throttling valves shall be used to provide the minimum gas flow.

B. Moderately Mixed Systems. For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded up to forty pounds of volatile solids per thousand cubic feet of volume per day (40 lbs/1000($ft^3 \cdot d$)) **or at a volumetric rate that provides not less than a thirty (30) day detention time** in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided**.** Provisions for mixing scum shall be included. Where actual data are not available, the following unit capacities **should** be used for plants treating domestic ~~*[sewage]*~~ **wastewater**:

1.Primary facility - 3 ft^3 /PE heated or 4 ft^3 /PE unheated
2. Primary and standard rate filter facility - 4 ft^3 /PE heated or 5 ft^3 /PE unheated
3. Primary and high rate filter facility - 4 ft^3 /PE heated or 5.5 ft^3 /PE unheated

C. Multistage Systems. For digestion systems utilizing two stages (primary and secondary units), the first stage (primary) may be either completely mixed or moderately mixed and loaded in accordance with completely or moderately mixed systems. The second stage (secondary) shall be designed for sludge storage, concentration, and gas collection and shall not be credited in the calculations for volumes required for sludge digestion.

D. Digester Mixing Facilities for mixing the digester contents shall be provided where required for proper digestion by reason of loading rates or other features of the system. Where sludge recirculation pumps are used for mixing they shall be provided in accordance with appropriate requirements of subsection(7)-Sludge Pumping and piping.

~~*[Calculations should be submitted to justify the basis of design. When the calculations are not based on these factors, the minimum combined digestion tank capacity outlined in paragraphs (5)(C)1. and 2. will be required.*~~

~~*2. The requirements assume that a raw sludge is derived from ordinary domestic wastewater, that a digestion temperature is to be maintained in the range of ninety degrees to one hundred degrees Fahrenheit (90°–100 °F) (32.2 °C–37.8 °C), that forty to fifty percent (40–50%) volatile matter will be maintained in the digested sludge, and that the digested sludge will be removed frequently from the system (see also paragraph (5)(A)1. of this rule).*~~

~~*1. Completely-mixed systems. Completely-mixed systems shall provide for intimate and effective mixing to prevent stratification and to assure homogeneity of digester content. The system may be loaded at a rate up to eighty pounds (80 lbs.) of volatile solids per one thousand (1000) cubic feet of volume per day (1.28 kg/m³/day) in the active digestion units. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered. Complete mixing can be accomplished only with substantial energy input.*~~

~~*2. Moderately-mixed systems. For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded at a rate up to forty pounds (40 lbs.) of volatile solids per one thousand (1000) cubic feet of volume per day (0.64 kg/m³/day) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided. Provisions for mixing scum shall be included.]*~~

~~*[(D)]*~~**(E)** Gas Collection, Piping and Appurtenances.

1. General. All portions of the gas system, including the space above the tank liquor, storage facilities and piping, shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

2. Safety equipment. All necessary safety facilities shall be included where gas is produced.

A. Pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves, shall be provided **and shall be protected from freezing**.

B. Water seal equipment shall not be installed.

C. Gas safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

3. Gas piping and condensate. **Gas piping shall have a minimum diameter of four inches (4"). A smaller diameter pipe at the gas production meter is acceptable.**

A. Gas piping shall slope to condensation traps at low points.

B. Float- controlled condensate traps shall not be used.

C. Condensation traps shall be protected from freezing.

D. Tightly fitted self-closing doors should be provided at connecting passageways and tunnels that connect digestion facilities to other facilities to minimize the spread of gas.

E. Piping galleries shall be ventilated in accordance with ventilation requirements in paragraph (7) below. ~~*[Gas piping shall be of adequate diameter and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.]*~~

F. Gas piping lines for anaerobic digesters shall be equipped with closed type indicating gauges. These gauges shall read directly in inches of water. Three gauges should be provided:

1. one to measure the main line pressure;
2. a second to measure the pressure to gas-utilization equipment; and
3. the third to measure pressure to waste burners.

G. Gas tight shut-off and vent cocks shall be provided. The vent piping shall be extended outside the building, and the opening shall be screened and arranged to prevent the entrance of rainwater.

H. All piping of the manometer system shall be protected with safety equipment.

I. Gas piping should be designed to maintain digester gas velocities less than twelve feet per second (12fps).

4. Gas utilization equipment. Gas-fired boilers for heating digesters shall be located in ~~*[a]*~~ **well ventilated** separate room**(s),** not connected to the digester gallery. The separated room would not ordinarily be classified as hazardous location **if isolated from the digestion gallery**. Gas lines to these units shall be provided with suitable flame traps.

5. Electrical fixtures**, equipment and controls**. Electrical **equipment,** fixtures**,** and controls**,** in places enclosing **and adjacent to** anaerobic digestive appurtenances where hazardous gases are normally contained in the tanks and/or piping shall comply with the National Electrical Code, Class I, **Division 1, Group D** ~~*[Group D, Division 2]*~~ locations. Digester galleries should be isolated from normal operating areas to avoid an extension of the hazardous location in accordance with paragraph (5)(D)7. of this rule.

6. Waste gas.

A. Location. Waste gas burners shall be readily accessible and should be located at least **fifty feet (50')** away from any plant structure if placed at ground level or may be located on the roof of the control building if sufficiently removed from the tank. **Waste gas burners shall be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.**

B. Gas Burners. All waste gas burners shall be equipped with automatic ignition such as a pilot light or a device using a photoelectric cell sensor. Consideration should be given to the use of natural or propane gas to ensure reliability of the pilot. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least ten feet (10') ~~*[(3 m)]*~~ above the ground surface, provided that the assembly incorporates a flame trap **and is in compliance with all applicable <u>Missouri</u> air regulations**.

C. Gas Piping Slope. Gas piping shall be sloped at a minimum of two percent (2%) up to the waste gas burner with a condensate trap provided in a location not subject to freezing.

7. Ventilation. Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation **for dry wells** in accordance with 10 CSR 20-8.130(4)(G) and 10 CSR 20-8.130(4)(G)2.

A. The piping gallery for digesters should not be connected to other passages. Where used, tightly fitting, self-closing doors should be provided at connecting passageways and tunnels to minimize the spread of gas.

B. The ventilation rate for Class I, Division 2, Group D locations including enclosed areas without a gas tight partition from the digestion tank or areas containing gas compressors, sediment traps, drip traps, gas scrubbers, or pressure regulating and control valves, if continuous, shall be at least twelve (12) complete air changes per hour.

8. Meter. A gas meter with bypass shall be provided to meter total gas production~~*[.]*~~ **for each active digestion unit. The gas meters shall be specifically designed for contact with corrosive and dirty gases. Orifice plate, turbine, or vortex gas meters should be used. Positive displacement meters should not be utilized.**

A. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping.

B. Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter shall be provided for each primary digestion unit.

C. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units.

D. Interconnected gas piping shall be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit and maintenance of either digestion unit.

~~*[(E)]*~~ **(F)** Digester Heating.

1. Insulation. Wherever possible digestion tanks should be constructed above groundwater level and **shall** ~~*[should]*~~ be suitably insulated to minimize heat loss. Maximum utilization of earthen bank insulation should be used.

2. Heating facilities. Sludge may be heated by circulating the sludge through external heaters or by heating units located inside the digestion tank.

A. External heating. Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate **heat exchanger tube removal and** cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements. **Heat exchangers should have a heating capacity of one hundred thirty percent (130%) of the calculated peak heating requirement to account for the occurrence of sludge tube fouling.**

B. Other heating methods.

1. Hot water heating coils affixed to the walls of the digester or other types of internal heating equipment that require emptying the digester contents for repair shall not be used.

2. Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own merits. Operating data detailing their reliability, operation, and maintenance characteristics will be required. Other types of heating facilities will also be **reviewed** ~~*[considered]*~~ on their own merits; **see 10 CSR 20-8.140(x)(x)-Innovative design.**

3. Heating capacity. **Sufficient heating capacity shall be provided to consistently maintain the design sludge temperature, considering insulation provisions and ambient cold weather conditions.** ~~*[Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided.]*~~

A. Where digestion tank gas is used for other purposes, an auxiliary fuel shall be required.

B.The design operating temperature should be in the range of 85°F to 100°F where optimum mesophilic digestion is required.

C. The provision of standby heating capacity or the use of multiple units sized to provide the heating requirements shall be considered, unless acceptable alternative means of handling raw sludge are provided for the extended period that a digestion process outage is experienced due to heat loss.

4. Hot water internal heating controls.

A. Mixing valves. A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat jacket can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable bypass valves.

B. Boiler controls. The boiler should be provided with suitable automatic controls to maintain the boiler temperature at ~~*[approxi-mately]*~~ **approximately** one hundred eighty degrees Fahrenheit (180 °F) ~~*[(82 °C)]*~~ to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level**, low gas pressure,** or excessive **boiler water** temperature **or pressure**.

C. Boiler Water Pumps. Boiler water pumps shall be sealed and sized to meet the operating conditions of temperature, operating head, and flow rate. Duplicate units shall be provided.

~~*[C]*~~**D**. Thermometers shall be provided to show **inlet and outlet** temperatures of the sludge, hot water feed, hot water return and boiler water. **It is recommended that a facility have a temperature probe and recording device to continuously record digester temperature.**

E. Water Supply. The chemical quality should be checked for suitability for use as a water supply. Refer to 10 CSR 20-8.140(x)(X) for regarding break tank requirements for indirect water supply connections.

F. External Heater Operating Controls All controls necessary to ensure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

(G) Biotowers. Reserved.

~~*[(F)]*~~ **(H)** Supernatant Withdrawal. **Where supernatant separation is to be used to concentrate sludge in the digester units and increase digester solids retention time, the design shall provide for ease of operation and positive control of supernatant quality.**

1. Piping size. Supernatant piping should not be less than six inches (6") ~~*[(15 cm)]*~~ in diameter.
2. Withdrawal arrangements.

A. Withdrawal levels. Piping should be arranged so that withdrawal can be made from three (3) or more levels in the digester. A positive pressure, unvalved, vented overflow shall be provided. **The emergency overflow shall be piped to an appropriate point and at an appropriate rate in the treatment process or side stream treatment units to minimize the impact on process units.**

B. **Withdrawal Selection. On fixed cover tanks, the supernatant withdrawal level should be selected by means of interchangeable extensions at the discharge end of the piping.**

1.Supernatant selector. **A fixed screen supernatant selector or similar type device shall be limited for use in an unmixed secondary digestion unit.**

2. If a supernatant selector is provided, provisions shall be made for at least one (1) other draw-off level located in the supernatant zone of the tank in addition to the unvalved emergency supernatant draw-off pipe. High pressure backwash facilities shall be provided.

3. Sampling. Provisions should be made for sampling at each supernatant draw-off level. Sampling pipes should be at least one and one-half inches (1.5") ~~*[(3.8 cm)]*~~ in diameter and should terminate at a suitably-sized sampling sink or basin.

4. Alternate supernatant disposal. **Supernatant return and disposal facilities should be designed to alleviate adverse hydraulic and organic effects on plant operations. If nutrient removal (e.g., phosphorus, ammonia nitrogen) must be accomplished at a plant, a separate supernatant side stream treatment system should be provided.** ~~*[Consideration should be given to supernatant conditioning where appropriate in relation to its effect on plant performance and effluent quality.]*~~

(H) Energy control. The use of digester gas as a heating fuel source is encouraged and should be utilized as a fuel whenever practical. The production of methane gas (CH_4) should be optimized.

1. Sufficient heating capacity shall be provided to maintain consistently the design temperature required for sludge stabilization. For emergency usage, an alternate source of fuel shall be available and the boiler or other heat source shall be capable of using the alternate fuel.

2. Sludge heating devices with open flames should be located above grade in areas separate from locations of gas production or storage.

3. If designing a cogeneration system, the summary of design shall include the calculations for the following parameters:

A. Volume of gas produced by digesters;

B. Digester gas energy value in British Thermal Units per cubic foot (BTUs/ft^3);

C. Gas composition;

D. Gas storage capability; and

E. Gas pretreatment requirements, including filtration requirements.

(6) Aerobic Sludge Digestion.

(A) General. Aerobic digestion can be used to stabilize primary sludge, secondary sludge or a combination of the two. Digestion is accomplished in single or multiple tanks designed to provide effective air mixing, reduction of the organic matter, supernatant separation and sludge concentration under controlled conditions.

1. Digestion tanks. ~~*[Multiple tanks are recommended.]*~~ **Multiple digestion units capable of independent operation are desirable and shall be provided in all plants where the design average flow equal to or greater than one hundred thousand gallons per day (100,000 gpd). For facilities less than one hundred thousand gallons per day (100,000 gpd),** ~~*[A]*~~ **a** single sludge digestion tank may be used ~~*[in the case of small treatment plants or]*~~ where adequate provision is made for sludge handling where a single unit will not adversely affect normal plant operations.

2. For an aerobic digester that concentrates waste sludge only by decanting a digester tank, the maximum solids concentration used to calculate the total retention time must be two percent (2.0%) unless supporting data is submitted to increase the solids concentration up to three percent (3.0%).

3. Aerobic digesters shall be equipped to control, suppress, or remove excessive foam. The design must consider provisions for the capture and control of foam outside the structure in the event of failure of equipment, seals, pipe penetrations, or access ports.

(B) Design Sludge Production

1. For calculating design sludge handling, sludge production values from aerobic digesters shall be based on a maximum solids concentration of two percent (2.0%) without additional thickening. The solids production values on a dry weight basis per population equivalent shall be based on the following for the listed processes:

A. For primary plus waste activated sludge, a minimum of 0.16 lbs/PE/day

B. For primary plus fixed film sludge, a minimum of 0.12 lb/PE/day

2. Digester volume shall be a minimum of 25% of the design average flow of the treatment works.

~~*[(B)]*~~**3.** Mixing and Air Requirements. Aerobic sludge digestion tanks shall be designed for effective mixing by satisfactory aeration equipment. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between one and two (1–2) mg/l.

A. A minimum mixing and oxygen requirement of thirty (30) cfm per one thousand (1000) cubic feet of tank volume ~~*[(30 l/min/m^3)]*~~ shall be provided with the largest blower out-of-service.

B. If diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service.

C. If mechanical turbine aerators are utilized, at least two turbine aerators per tank shall be provided to permit continuity of service.

D. If mechanical aerators are utilized, a minimum of 1.0 horsepower per one thousand (1000) cubic feet ~~*[(28.3m^3)]*~~ should be provided. **Mechanical aerators are not recommended for use in aerobic digesters where freezing conditions will cause ice build-up on the aerator and support structures. Protection against freezing conditions must be included when using mechanical aerators.** ~~*[Use of mechanical equipment is discouraged where freezing temperatures are normally expected.]*~~

E. The minimum quantity of oxygen provided shall be based on two and one-tenth pounds (2.1 lbs) of oxygen per pound of volatile solids destroyed for open tank systems; or one and half pounds (1.5 lbs) of oxygen per pound of volatile solids destroyed for thermophilic systems.

4. A reduction in requirements for hydraulic detention time may be given for aerobic digestors designed to be operated in the extended aeration mode, or coupled with additional stabilization processes, or operated at elevated temperatures. In the Summary of Design include calculations for determining the hydraulic detention time.

(C) Tank Capacity. The determination of tank capacities shall be based on rational calculations, including such factors as quantity of sludge produced, sludge characteristics, time of aeration and sludge temperature.

1. Volatile solids loading. It is recommended that the volatile suspended solids loading not exceed one hundred pounds per one thousand cubic feet (100 lb/1000 ft^3) of volume per day ~~*[(1.60 kg/m³/day)]*~~ in the digestion units. Lower loading rates may be necessary depending on temperature, type of sludge and other factors. **In the Summary of Design include calculations on the volatile solids loading rates.**

2. Solids retention time. Required minimum solids retention time for stabilization of biological sludges vary depending on type of sludge. Normally, a minimum of fifteen (15) days' retention should be provided for waste activated sludge and twenty (20) days for combination of primary and waste activated sludge, or primary sludge alone. Where sludge temperature is lower than fifty degrees Fahrenheit (50 °F) ~~*[(10 °C)]*~~, additional detention time should be considered.

3. The following digestion tank capacities are based on a solids concentration of two percent (2.0%) with supernatant separation performed in a separate tank.

A. If supernatant separation is performed in the digestion tank, a minimum of twenty-five percent (25%) additional volume shall be provided.

B. These capacities shall be provided unless sludge thickening facilities are utilized to thicken the feed solids concentration to greater than two percent (2.0%). If such thickening is provided, the digestion volumes may be decreased proportionally.

C. For facilities with waste activated sludge from a single stage nitrification facility with less than twenty-four (24) hours detention time based on design average flow, they shall use the waste activated sludge-no primary settling volume in Table 170-X below.

D. The volumes in Table 170-X below are based on digester temperatures of 59°F and a solids retention time of twenty-seven (27) to sixty (60) days. Aerobic digesters should be covered to minimize heat loss for colder temperature applications. Additional volume or supplemental heat may be required if the land application disposal method is used.

Table 170-X: Minimum Volume per Population Equivalent

Sludge Source	Volume/Population Equivalent (ft^3/P.E.)
Waste activated sludge-no primary settling	4.5
Primary plus waste activated sludge	4.0
Waste activated sludge exclusive of primary sludge	2.0
Extended Aeration Activated Sludge	3.0
Primary plus attached growth biological reactor sludge	3.0

(D) Supernatant Separation. ~~*[Facilities shall be provided for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease.]*~~ **Supernatant separation facilities shall be provided for effective separation or decanting of supernatant. Separate facilities are recommended; however, supernatant separation may be accomplished in the digestion tank if additional volume is provided per subsection(C) of this rule-Tank Capacity.**

1.The supernatant drawoff unit shall be designed to prevent recycle of scum and grease back to

plant process units.

2. Supernatant withdrawal. Design for supernatant withdrawal shall occur at least 6 inches below the liquid surface level after a minimum one-hour settling period; however provision should be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone. Return supernatant to the head of the plant.

(E) Autothermal Thermophilic Aerobic Digestion. Thermophilic digestion temperature should be maintained between 122°F and 158°F. Systems may be either single or multiple stage. The sludge should be thickened prior to treatment in the digestion tanks. The digestion tanks should be suitably insulated to minimize heat loss.

(F) Scum and Grease Removal Facilities shall be provided for the effective collection of scum and grease from the aerobic digester for final disposal, to prevent its recycle back to the plant process, and to prevent long term accumulation and potential discharge in the effluent.

(G) Sludge Storage. Sludge storage shall be provided in accordance with subsection (X) of this rule to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions. Designs shall not utilize increased sludge age in the activated sludge system as a means of storage. Liquid sludge storage facilities shall be based on the following values unless digested sludge thickening facilities are utilized to provide solids concentrations of greater than two percent (2.0%).

Table 170-X: Minimum Volume per Population Equivalent per Day

Sludge Source	Volume/Population Equivalent (ft^3/PE/day)
Waste activated sludge-no primary settling	0.13
Primary plus waste activated sludge	0.13
Waste activated sludge exclusive of primary sludge	0.06
Extended Aeration Activated Sludge	0.13
Primary plus attached growth biological reactor sludge	0.10

(H) High Level Emergency Overflow. An unvalved emergency overflow shall be provided that will convey digester overflow to the WWTP headworks, the aeration process, or to another liquid sludge storage facility and that has an alarm for high level conditions. Design considerations related to the digester overflow shall include waste sludge rate and duration during the period the plant is unattended, potential effects on plant process units, discharge location of the emergency overflow, and potential discharge of suspended solids in the plant effluent.

(I) Operations and Maintenance Considerations

1. A sampling line (at least 1.5 inches in diameter) with a quick closing valve no more than one foot (1 ft) from the tank bottom shall be provided.

2. The plant shall have dissolved oxygen meters to test the dissolved oxygen in the digestor.

3. The facility shall have the ability to address excessive foaming, such as hosing equipment and access to water.

4. The facility shall have a method and equipment to raise the air diffusers to facilitate cleaning and maintenance.

5. For maintenance, the tank bottoms shall slope toward the sludge withdrawal pipe and have a minimum slope of at least 1 foot vertical to 4 feet horizontal.

Comment [D2]: Comment that this seems steep; other suggestions or thoughts?

(7) Sludge Pumps and Piping.

(A) Sludge Pumps.

1. Capacity. **Sludge pumping systems shall be designed with adequate capacity to cover the full range of anticipated solids concentrations and sludge production rates. Operating pressures and head losses shall be calculated to account for the higher friction factors associated with the type of sludge being pumped.** ~~*[Pump capacities should be adequate but not excessive.]*~~ Provision

for varying pump capacity is desirable. **A rational basis of design with calculations shall be provided with the summary of design.**
2. Duplicate units. Duplicate units shall be provided all installations. ~~*[where failure of one (1) unit would seriously hamper plant operation.]*~~
3. Type. Plunger pumps, screw feed pumps, recessed impeller type centrifugal pumps, progressive cavity pumps or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Where centrifugal pumps are used, a parallel **positive displacement shall be provided as an alternate to pump heavy sludge concentrations, such as primary or thickened sludge, that may exceed the pumping head of the centrifugal pump.** ~~*[plunger type pump should be provided as an alternate to increase reliability of the centrifugal pump.]*~~
4. Minimum head. A minimum positive head of twenty-four inches (24") ~~*[(61 cm)]*~~ shall be provided at the suction side of centrifugal type pumps and **should be provided** ~~*[is desirable]*~~ for all types of sludge pumps. Maximum suction lifts should not exceed ten feet (10') ~~*[(3m)]*~~ for plunger pumps.
5. Sampling facilities. Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least one and one-half inches **(1.5")** ~~*[(1-1/2") (3.8 cm)]*~~ **and terminate at a suitably sized sampling sink or floor drain.**
6. For sludge pumping systems, alarms shall be provided for:
A. Pump failure;
B. Loss of pressure; and
C. High pressure.
7. Sludge pumps shall be equipped with high pressure shutoff switches
(B) Sludge Piping.
1. Size and head. Sludge withdrawal piping should have a minimum diameter of eight inches (8") ~~*[(20.3 cm)]*~~ for gravity withdrawal and **four inches (4")** ~~*[six inches (6") (15.2 cm)]*~~ for pump suction and discharge lines. Where withdrawal is by gravity the available head on the discharge pipe should be **at least four feet (4') greater than the calculated head loss. All sludge piping systems shall be designed to provide a velocity of at least two feet per second (2fps).** ~~*[adequate to provide at least three feet (3') per second (0.9m/sec) velocity.]*~~
2. Slope. Gravity piping should be laid on uniform grade and alignment.
A. The slope of gravity discharge piping should not be less than three percent (3%) **for primary sludges and all sludges thickened to greater than two percent (2%) solids.**
B. Slope on gravity discharge piping should not be less than two percent (2%) for aerobically digested sludge or waste activated sludge with less than two percent (2%) solids.
C. Cleanouts shall be provided for all gravity sludge piping.
D. Provisions should be made for cleaning, draining and flushing discharge lines.
E. All sludge piping shall be suitably located or otherwise adequately protected to prevent freezing.
3. Supports. Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.
4. Air release valves shall be installed at the high points in the piping system.

(8) Sludge De-watering. **On-site sludge dewatering facilities should be provided for all mechanical plants, although the following requirements may be reduced with on-site liquid sludge storage facilities or approved off-site sludge disposal. For facilities in which sludge is not available or is likely to change considerably in nature, successful performance from multiple facilities handling similar sludges under similar conditions and design criteria shall be documented and used to develop appropriate design criteria.**
(A) Sludge Drying Beds. **Sludge drying beds may be used for dewatering well digested sludge from either the anaerobic or aerobic process. Due to the large volume of sludge produced by the aerobic digestion process, consideration should be given to using a combination of dewatering systems or other means of ultimate sludge disposal.**

1. Unit Sizing. Sludge drying bed area shall be calculated on a rational basis with the following items considered:

- **A. The volume of wet sludge produced by existing and proposed processes.**
- **B. Depth of wet sludge drawn to the drying beds. For design calculation purposes, a maximum depth of eight inches (8") shall be utilized. For operational purposes, the depth of sludge placed on the drying bed may increase or decrease from the design depth based on the percent solids content and type of digestion utilized.**
- **C. Total digester volume and other wet sludge storage facilities.**
- **D. Degree of sludge thickening provided after digestion.**
- **E. The maximum drawing depth of sludge which can be removed from the digester or other sludge storage facilities without causing process or structural problems.**
- **F. The time required on the bed to produce a removable cake. Adequate provisions or methods shall be made for sludge dewatering and/or sludge disposal facilities for those periods of time during which outside drying of sludge on beds is hindered by weather.**
- **G. Capacities of auxiliary dewatering facilities.**

~~*[1.]*~~ **2**. Area. In determining the area of sludge drying beds, consideration shall be given to climatic conditions, the character and volume of the sludge to be de-watered, the method and schedule of sludge removal and other methods of sludge disposal. ~~*[(It should be recognized that, in northern areas of the country, the drying season is only six (6) months a year.) In general, the]*~~ **The** sizing of the drying bed may be estimated on the basis of 2.0 ft^2/capita ~~*[(0.2 m^2/capita)]*~~ when the drying bed is the primary method of de-watering, and 1.0 ft^2/capita ~~*[(0.1 m^2/capita)]*~~ if it is to be used as a back-up de-watering unit. ~~*[An increase of bed area by twenty-five percent (25%) is recommended for paved-type bed.]*~~

~~*[2]*~~**3**. Percolation type. The lower course of gravel around the underdrains should be properly graded and should be twelve inches (12") ~~*[(30 cm)]*~~ in depth, extending at least six inches (6") ~~*[(15.2 cm)]*~~ above the top of the under drains. It is desirable to place this in two (2) or more layers. The top layer of at least three inches (3") ~~*[(7.6 cm)]*~~ should consist of gravel one-eighth inch (1/8") to one-fourth inch (1/4") ~~*[(3.2–6.4 mm)]*~~ in size.

- A. Sand. The top course should consist of at least **nine to twelve inches** ~~*[six to nine inches (6"–9") (15–23 cm)]*~~ of clean**, hard, and washed** coarse sand. **The effective size of the sand should be in the range of 0.8 mm to 1.5 mm.** The finished sand surface should be level.
- B. Underdrains. Underdrains should be ~~*[clay pipe or concrete drain tile]*~~ at least four inches (4") ~~*[(10 cm)]*~~ in diameter **<u>and</u>** laid with open joints. Underdrains should be spaced not more than twenty feet (20') ~~*[(6 m)]*~~ apart **and sloped at a minimum of one percent (1%)**. **Lateral tiles should be spaced at eight to ten feet (8-10'). Various pipe materials may be selected provided the pipe is corrosion resistant and appropriately bedded to ensure that the underdrains are not damaged by sludge removal equipment. Perforated pipe may also be used.** As to the discharge of the underdrain filtrate, refer to subsection (8)(C) of this rule.
- **C. Additional dewatering provisions should be considered to provide a means of decanting the supernatant of sludge placed on the sludge drying beds. More effective decanting of supernatant may be accomplished with polymer treatment of sludge.**
- **D. The bottom of the percolation bed shall be sealed in a manner approved by the department.**
- **E. Paved surface beds shall be prohibited.** ~~*[3. Partially paved type. The partially paved type drying bed should be designed with consideration for space requirement to operate mechanical equipment for removing the dried sludge.]*~~

4. Walls. [~~*Walls should be watertight and extend fifteen to eighteen inches (15"–18") [(38 cm–46 cm)] above and at least six inches (6") [(15 cm)] below the surface. Outer walls should be curbed to prevent soil from washing onto the beds.]*~~**Walls should extend eighteen inches (18") above and at least nine inches (9") below the surface of the sludge drying bed. Outer walls shall be water tight down to the bottom of the bed and extend at least four inches (4") above the**

outside grade elevation to prevent soil from washing into the beds.

5. Sludge removal. Not less than two (2) beds should be provided and they should be arranged to facilitate sludge removal. ~~*[Concrete truck tracks should be provided for all percolation type sludge beds.]*~~ Pairs of tracks for percolation type should be on twenty-foot (20') ~~*[(6 m)]*~~ centers. **Each sludge drying bed shall be constructed so as to be readily and completely accessible to mechanical equipment for cleaning and sand replacement. Concrete runways spaced to accommodate mechanical equipment shall be provided. Special attention should be given to assure adequate access to the areas adjacent to the sidewalls. Entrance ramps down to the level of the sand bed shall be provided. These ramps should be high enough to eliminate the need for an entrance end wall for the sludge bed.**
6. Sludge influent. The sludge pipe to the drying beds should terminate at least twelve inches (12") ~~*[(30 cm)]*~~ above the surface and be so arranged that it will drain. Concrete splash plates for percolation type should be provided at sludge discharge points.
7. Protective enclosure. A protective enclosure shall be provided if winter operation is required.

(B) Mechanical **Dewatering** ~~*[De-watering]*~~ Facilities. Provision shall be made to maintain sufficient continuity of service so that sludge may be **dewatered** ~~*[de-watered]*~~ without accumulation beyond storage capacity. The number of vacuum filters, centrifuges, filter presses, belt filters or other mechanical **dewatering** ~~*[de-watering]*~~ facilities should be sufficient to **dewater** ~~*[de-water]*~~ the sludge produced with one (1) largest unit out-of-service. Unless other standby facilities are available, adequate storage facilities shall be provided. The storage capacity should be sufficient to handle at least a three (3)-month sludge production. **Documentation shall be submitted justifying the basis of design of mechanical dewatering facilities in the summary of design.**

1. Auxiliary facilities per vacuum filters. There shall be a back-up vacuum pump and filtrate pump installed for each vacuum filter. It is permissible to have an uninstalled back-up vacuum pump or filtrate pump for every three (3) or less vacuum filters, provided that the installed unit can easily be removed and replaced.
2. Ventilation. Adequate facilities shall be provided for ventilation of **dewatering** ~~*[de-watering]*~~ area. The exhaust air should be properly conditioned to avoid odor nuisance.
3. Chemical handling enclosures. Lime-mixing facilities should be completely enclosed to prevent the escape of lime dust. Chemical handling equipment should be automated to eliminate the manual lifting requirement.
4. **Mechanical dewatering units shall be capable of handling the maximum weekly sludge production in thirty (30) hours, unless the equipment is designed for continuous operation.**

(C) Centrifuges. Centrifugal dewatering of sludge is a process which uses the force developed by fast rotation of a cylindrical drum or bowl to separate the sludge solids from the liquid. The Summary of Design shall include a sludge characterization with the necessary polymer and coagulant dosage to achieve the design solids content. The abrasiveness of each sludge supply shall be considered in scroll selection. Adequate sludge storage shall be provided for proper operation.

1. **Unless dual trains are provided, the following spare appurtenant equipment shall be provided, with necessary connecting piping and electrical controls to allow easy installation:**
   - **A. Drive motor.**
   - **B. Gear assembly.**
   - **C. Feed pump.**
2. **Each feed pump shall be variable speed. A pump for each centrifuge shall be provided within the feed system.**
3. **Each centrifuge shall be equipped with provisions for variation of scroll speed and pool depth.**
4. **A crane or monorail shall be provided for equipment removal or maintenance.**
5. **Provision for adequate and efficient wash down of the <u>machine</u> interior shall be an integral part of the design.**

(D)Belt Press. Actual performance data developed from similar operational characteristics shall be utilized for design.

1. The impact that anticipated sludge variability will have on the design variables for the press as well as chemical conditioning shall be addressed in the Summary of Design.

2.A second belt filter press or an approved backup method of dewatering shall be required whenever :

- **A. a single belt press is operated sixty (60) hours or more within any consecutive five (5) day period, or**
- **B. the average daily flow received at the treatment works equals or exceeds one million gallons per day (1 MGD).**
- **C. Appropriate scale-up factors shall be utilized for full-size designs if pilot plant testing is performed in lieu of full-scale testing.**

3. Sludge feed shall be as constant as possible to eliminate difficulties in polymer addition and press operation. The range in feed variability shall be identified and equalization shall be provided as necessary. A method for uniform sludge dispersion on the belt shall be provided. Grinders for the sludge feed to the flocculation system must be considered. Thickening of the feed sludge should be an integral part of the design of the filter press.

4. The filter press design shall consider the following:

- **A. Variable belt speed mechanism.**
- **B. Belt tracking and belt tensioning equipment.**
- **C. Belt replacement availability based on evaluation of the belt equipment selection especially if the weave, material, width, or thickness cannot be reasonably duplicated.**

5. The sizing, design, and location of the filter press should consider:

- **A. Drip trays under the press and under the thickener to readily remove filtrate if gravity belt thickening is employed;**
- **B. Adequate clearance to the side and floor for maintenance and removal of the dewatered sludge;**
- **C. Location of all electrical panels or other materials that are subject to corrosion out of the area of the press; and**
- **D. Adjustable doctor blade clearance.**

6. The Summary of Design shall include the polymer selection methodology, accounting for sludge variability and anticipated sludge loading to the press including all calculations for sizing, loading, and dosage.

7. The rollers utilized with the belt filter press shall be specified in the design and should provide:

- **A. Rubber coating or other protective finish.**
- **B. Maximum frame and roller deflection and operating tension.**
- **C. Roller bearings that is watertight and rated for a B-10 life of one hundred thousand (100,000) hours.**

8. The washwater system should provide for:

- **A. High pressure washwater for each belt with a specified operating pressure;**
- **B. Booster pumps if necessary;**
- **C. Spray wash systems designed to be cleaned without interference with the system operation;**
- **D. Particular care in nozzle selections and optional nozzle cleaning systems when recycled wastewater is used for belt washing;**
- **E. Replaceable spray nozzles; and**
- **F. Spray curtains.**

9. Requirements for spare appurtenances should include the following:

- **A. Complete set of belts;**
- **B. One set of bearings for each type of press bearing;**
- **C. Tensioning and tracking sensors;**
- **D. One set of wash nozzles;**
- **E. Doctor blade; and**
- **F. Conditioning or flocculation drive equipment if duplicate units are not provided.**

10. Belt presses and conveyors shall be provided with emergency pull cords along the entire length of the press that will:
A. Stop the press in an emergency; and
B. Trigger an audible alarm.

(E) Screw Press. **Reserved**.
(F) Rotary Fan Press. **Reserved.**
(G) Biomembrane bags.

(H)~~*[(C)]*~~ Drainage and Filtrate Disposal. Drainage from beds or filtrate from **dewatering** ~~*[de-watering]*~~ units shall be returned to the **wastewater** ~~*[sewage]*~~ treatment process at appropriate points **and rates**. **Dewatering sidestreams shall be returned to the treatment process as far upstream as practicable prior to the biological treatment unit. Sampling equipment shall be provided as needed to monitor drainage and filtrate waste streams.**
(I)~~*[(D)]*~~ Other **Dewatering** ~~*[De-watering]*~~ Facilities. If it is proposed to **dewater** ~~*[de-water]*~~or dispose of sludge by other methods, a detailed description of the process and design data shall accompany the plans. **See 10 CSR 20-8.140(x) for discussion of new process demonstrations.**
(J) Alarm systems shall be provided to notify the operator(s) of conditions that could result in process equipment failure or damage, threaten operator safety, or a sludge spill or overflow condition.
1. Automatic shutdowns should be provided to prevent equipment failure.

(9) Storage.
(A) General. Sludge storage facilities shall be provided at all treatment plants. Appropriate storage facilities may consist of any combination of drying beds, lagoons, separate tanks, additional volume in sludge stabilization units, pad areas or other means to store either liquid or dried sludge. The design shall provide for odor control in sludge storage tanks and sludge lagoons including aeration, covering, or other appropriate means so that odors do not create a nuisance at the property boundary.
(B) Design. The summary of design shall include storage volumes. Rational calculations justifying the number of days of storage to be provided shall be submitted and shall be based on the total sludge and/or biosolids handling and disposal system.

1. **Sludge production values for stabilization processes should be justified in the basis of design.**
2. **Storage areas shall be designed to minimize tracking of dewatered cake on-site and eliminate runoff from the dewatered cake storage area to other portions of the site or off-site.**
3. **For dewatered sludge, provide concrete or equivalent surfaced facilities with appropriate drainage systems to store treated sludge.**
4. **Drainage systems must return supernatant or other liquids to the headworks of the treatment system.**
5. **Sludge storage must accommodate daily sludge production volumes and function as an operational buffer for unit outage and adverse weather conditions. Designs utilizing increased sludge age in the activated sludge system as a means of storage are not acceptable.**
6. **Liquid high pH stabilized sludge shall not be stored in a lagoon. Liquid sludge shall be stored in a tank or vessel equipped with rapid sludge withdrawal mechanisms for sludge disposal or retreatment. On-site storage of dewatered high pH stabilized sludge shall be limited to thirty (30) days. There shall be no off-site storage of high pH stabilized sludge. Provisions for rapid retreatment or disposal of dewatered sludge stored on-site shall also be made in case of sludge pH decay.**
7. **For facilities that transport sludge to another facility as the means of disposal, storage capacity shall be designed to accommodate at least ten (10) days of sludge production based on maximum month design sludge generation rate.**
8. **Disposal. General Drainage facilities for sludge vehicle transfer stations shall be provided to allow any spillage or washdown material to be collected and returned to the wastewater treatment plant or sludge storage facility.**
9. **If the land application method of biosolids disposal is the only means of disposal utilized at a treatment plant, storage shall be provided based on the following considerations, at a minimum:**

A. Inclement weather effects on access to the application land;
B. Temperatures including frozen ground and stored sludge cake conditions;
C. Haul road restrictions including spring thawing conditions;
D. Area seasonal rainfall patterns;
E. Cropping practices on available land;
F. Potential for increased sludge volumes from industrial sources during the design life of the plant; and
G. Available area for expanding sludge storage;
H. Appropriate pathogen reduction and vector attraction reduction requirements. A minimum range of one hundred twenty to one hundred eighty (120-180) days storage should be provided for the design life of the plant unless a different period is approved on a case-by-case basis.

(C) Sludge <u>and Biosolids</u> Storage Lagoons. General Sludge storage lagoons may be permitted only upon proof that the character of the sludge and the design mode of operation are such that offensive odors will not result. Where sludge lagoons are permitted, adequate provisions shall be made for other acceptable sludge handling methods in the event of upset or failure of the sludge digestion process. Sludge storage lagoons are temporary facilities and are not required to obtain a solid waste permit under 10 CSR 80. In order to maintain sludge storage lagoons as storage facilities, accumulated sludge must be removed routinely, but not less than once every two years unless an alternate schedule is approved in the operating permit.

1. Location. Sludge lagoons shall be located as far as practicable from inhabited areas or areas likely to be inhabited during the lifetime of the structures. Siting of sludge lagoons shall comply with the requirements of the 10 CSR 20-8.200(x).
2. Seal. Adequate provisions shall be made to seal the sludge lagoon bottoms and embankments in accordance with the requirements of 10 CSR 20-8.200(x). to prevent leaching into adjacent soils or ground water. The seal shall be protected to prevent damage from sludge removal activities. Groundwater monitoring may be required based on the recommendations of Missouri Geological Survey.
3. Access. Provisions shall be made for pumping or heavy equipment access for sludge removal from the sludge lagoon on a routine basis.
4. Supernatant Disposal. Lagoon supernatant shall be returned to the wastewater treatment process at appropriate points and rates. Sampling equipment shall be provided as needed to monitor supernatant waste streams.

(10)Chemical treatment.

Comment [D3]: Should this include polymers?

(A) The fundamental design areas to be considered include chemical feeding, mixing, and storage capacity. Chemical treatment operation controls shall include pH, contact time and mixture temperature.
1. Multiple units shall be provided unless nuisance-free storage or alternate stabilization methods are available to avoid disruption to treatment works operation when units are not in service.
2. If a single system is provided, standby conveyance and mixers, backup heat sources, dual blowers, etc., shall be provided as necessary. A reasonable downtime for maintenance and repair based on data from comparable facilities shall be included in the design. Adequate storage for process, feed, and downtime shall be included.
3. Either mechanical or aeration agitation should be provided to ensure uniform discharge from storage bins.

(B) Equipment. The design of the feeding equipment shall be determined by the treatment plant size, type of alkaline material used, slaking required, and operator requirements. Equipment may be either of batch or automated type.
1. Automated feeders may be of the volumetric or gravimetric type depending on accuracy, reliability, and maintenance requirements.
2. Manually operated batch slaking of quicklime (CaO) should be avoided unless adequate protective clothing and equipment are provided.

3. At small plants, hydrated lime [Ca(OH)2] should be used instead of quicklime due to safety and labor-saving reasons.
4. Feed and slaking equipment shall be sized to handle a minimum of 150% of the peak sludge flow rate including sludge that may need to be retreated due to pH decay.
5. Material delivered in bags shall be stored indoors and elevated above floor level. Bags should be of the multi-wall moisture-proof type.
6. Dry bulk storage containers shall be as airtight as practical and shall contain a mechanical agitation mechanism.
7. Storage facilities shall be sized to provide a minimum of a thirty (30) day supply.

(C) Alkaline material may be added to liquid primary or secondary sludges for sludge stabilization in lieu of digestion facilities; to supplement existing digestion facilities; or for interim sludge handling. There is no direct reduction of organic matter or sludge solids with the high pH stabilization process. There is an increase in the mass of dry sludge solids. Without supplemental dewatering, additional volumes of sludge will be generated. The design shall account for the increased sludge quantities for storage, handling, transportation, and disposal methods and associated costs.

1. Sufficient alkaline material shall be added to liquid sludge in order to produce a homogeneous mixture with a minimum pH of twelve (12 SU) after two (2) hours of vigorous mixing. Facilities for adding supplemental alkaline material shall be provided to maintain the pH of the sludge during interim sludge storage periods
2. The additive/sludge blending or mixing vessel shall be large enough to hold the mixture for thirty (30) minutes at maximum feed rate.
3. Mixing tanks may be designed to operate as either a batch or continuous flow process. A minimum of two (2) tanks shall be provided. The tanks shall provide a minimum of two (2) hours contact time in each tank. The following items shall also be considered in determining the number and size of tanks:
  A. peak sludge flow rates;
  B. storage between batches;
  C. dewatering or thickening performed in tanks;
  D. repeating sludge treatment due to pH decay of stored sludge;
  E. sludge thickening prior to sludge treatment; and
  F. type of mixing device used.
4. Mixing equipment shall be designed to provide vigorous agitation within the mixing tank, maintain solids in suspension, and provide for a homogeneous mixture of the sludge solids and alkaline material. Mixing may be accomplished either by diffused air or mechanical mixers.
A. If diffused aeration is used, an air supply of thirty cubic feet per minute per one thousand cubic feet (30 cfm/1000 ft^3) of mixing tank volume shall be provided with the largest blower out of service. When diffusers are used, the nonclog type should be provided, and they should be designed to permit continuity of service. The mixing tank shall be adequately ventilated and odor control equipment shall be provided.
B. If mechanical mixers are used, the impellers shall be designed to minimize fouling with debris in the sludge and consideration shall be made to provide continuity of service during freezing weather conditions. Mechanical mixers should be sized to provide five to ten horsepower per thousand cubic feet (5-10 HP/ 1,000 ft^3) of tank volume.
5. Pasteurization vessels shall be designed to provide for a minimum retention period of thirty (30) minutes. The means for provision of external heat shall be specified in the summary of design.

(D) Chlorine treatment. The stabilization of sludge by high doses of chlorine should be considered on a case-by-case basis. Process equipment that comes into contact with sludges that have not been neutralized after chlorine oxidation shall be constructed of acid resistant materials or coated with protective films. Caution should be exercised with recycle streams from dewatering devices or sludge drying beds which have received chlorine stabilized sludge due to the creation of potential toxic byproducts which may be detrimental to the treatment process or receiving stream.

(E) Other treatment. Other processes for chemical treatment can be considered in 10 CSR 20-8.140(x).

(11) Composting.

(A) Conventional sludge composting facilities aerobically process digested, or otherwise treated, sludge that is uniformly mixed with other organic materials and bulking agents to facilitate biological decomposition of organics. <u>The summary of design shall identify the methods of mixing, aeration, the carbon to nitrogen ratio and characteristics, other organic materials to be used, and how the compost will meet the Class B or Class A requirements.</u>

(B) General design <u>considerations</u>. <u>The summary of design shall include:</u>

1. The buffer distances, at a minimum shall meet the requirements in subsection (12) of this rule. Local jurisdictions may have more protective requirements that shall be met. <u>The summary of design shall document if there are more protective buffer distances required.</u>

2. All-weather roads to and from the facility, as well as between the various process operations.

3. Provisions for cleaning all sludge transport or residual hauling trucks that return to public roads, shall be provided at all compost facilities. Wash water shall be collected for necessary treatment.

4. The receiving, mixing, composting, curing, drying, screening, and storage areas shall be paved with asphaltic concrete, reinforced concrete, or other impervious, structurally stable material.

5. The facility shall be graded to prevent uncontrolled runoff and a suitable drainage system shall be provided to collect all process wastewater and direct it to storage and<u>/or</u> treatment facilities. Process wastewater includes water collected from paved process areas <u>and from the truck wash water</u>. The capacity of the drainage system, including associated storage or treatment works system shall be based on the <u>1 in 10 year, 24 hour storm event.</u>

6. All facility process wastewater and sanitary wastewater shall be collected and treated prior to discharge.

7. <u>W</u>here a separate bulking agent is required, a storage area for a six-month supply of the bulking agent shall be provided, unless the applicant can demonstrate that bulking agent supplies can be replenished more frequently.

(C) Facilities. A weigh scale or volumetric method shall be provided for determining the amount of sludge or residuals delivered to the facility and the amount of compost material removed from the facility. Adequate space and equipment must be provided for mixing operations and other material handling operations.

1. Where liquid, or dewatered, sludge or residuals are processed by the compost facility, all receiving of such inputs shall occur in:

A. An area that drains directly to a storage, treatment, or disposal facility;

B. A handling area which shall be hard-surfaced and diked to prevent entry of runoff or escape of the liquids; or

C. A sump with an adequately sized pump located at the low point of the hard-surfaced area shall be provided to convey spills to a disposal or holding facility.

2. Effective mixing equipment should be provided for use at all compost facilities. At facilities handling liquid or dewatered residual materials that must be mixed prior to composting, a mixing operation shall be provided. The operation shall have sufficient capacity to properly process the peak daily input with the largest mixer out of operation. <u>The summary of design shall establish the necessary mixing capacity,</u> either based on the material volume resulting from the sludge to bulking agent ratio or estimated from previous experience.

3. The ability of all selected equipment to produce a compostable mix from sludge of established moisture content, residual material, and the selected bulking agent shall be documented in the <u>summary of design</u>.

4. Except for windrow composting wherein mobile mixers are used, an area with sufficient space to mix the bulking agent and sludge or residuals and store the daily peak input shall

be provided. The mixing area shall be covered to prevent ambient precipitation from directly contacting the mix materials.

5. **Where conveyors are used to move the compost mix to the composting area and or help provide mixing, sufficient capacity shall be provided to permit handling of the mix with one conveyor out of operation, or a backup method of handling or storing shall be provided. Runoff shall be directed to storage or treatment facility. Capacity of the drainage system shall be based on the <u>1 in 10 year, 24 hour storm event.</u>**

(D) System design. The system design shall be sufficient to provide the level of treatment required for protection of public health and welfare as required to meet the <u>503(b) Class B or Class A requirements and provide a minimum storage time of six (6) months</u>.

1. **Consideration should be given to covering the compost mixing pad, curing area and drying area in order to allow for handling of bulking agents and treated sludge and the finished compost, during extended periods of precipitation. <u>The cover should be designed so that sunlight is transmitted to the composting materials while preventing direct contact with ambient precipitation.</u> If a roof <u>or</u> cover is not provided, operation of the facility during critical weather periods shall be addressed <u>in the summary of design</u>.**
2. **Sufficient equipment shall be provided for routinely measuring the temperature and oxygen at multiple points and depths within the compost piles.**
3. **Screening shall be provided for all compost facilities where the compost disposition necessitates the use of a screened product or where the bulking agent must be recycled and reused. A daily screening capacity of two hundred percent (200%) of the average daily amount of compost mix shall be provided when screening is required.**
4. **Windrow method. The area requirements shall be based on the average daily compost mix inputs, a minimum detention time of thirty (30) days on the compost pad, and the area required for operation of the mixing equipment. <u>The summary of design shall document that</u> sufficient compost mix handling equipment shall be provided to turn the windrows on the frequency established by the operations.**
5. **Aerated-static pile method. The aerated-static pile area requirement shall be based on the average daily compost mix inputs, along with storing base and cover material, with a composting time of twenty-one (21) days, unless the applicant can demonstrate that less time is necessary to achieve the requirements. The compost mix pile shall be provided with a means of uniformly distributing air flow <u>which will be identified in the summary of design.</u> Compost mix piles should be configured to provide adequate aeration of the mix using either positive or negative pressure for air flow through the piles.**
6. **Confined composting methods. Due to the large variation in composting processes, equipment types, and process configuration characteristic of confined systems, such as enclosed operations or in-vessel systems, a confined composting system will not be approved unless the applicant can demonstrate, through previous operating experience <u>and meeting the innovative technology requirements in 10 CSR 20-8.140,</u> that the material removed from the enclosed compost process, after <u>meeting the minimum</u> manufacturer's suggested residence time, has an equivalent or higher degree of stabilization than would be achieved after twenty-one (21) consecutive days of aerated static pile composting.**

(E) Aeration. Sufficient blower capacity shall be provided to deliver the necessary air flow through the compost mix, but the delivered air flow shall not be less than a minimum aeration rate of five hundred cubic feet per hour per dry ton (500 CFH/DT).

1. **Where centralized aeration is utilized, multiple blower units shall be provided and shall be arranged so that the design air requirement can be met with the largest single unit out of service.**
2. **Where individual or separated blowers are used, sufficient numbers of extra blowers shall be provided so that the design air requirement can be met with 10% of the blowers out of service.**

3. **For facilities that are not continuously manned, the blower units should be equipped with automatic reset and restart mechanisms or alarmed to a continuously manned station, so that they will be placed back into operation after periods of power outage.**
4. **Each pile aeration distribution header shall be provided with a throttling control valve. The aeration system shall be designed to permit both suction and forced aeration. The piping system shall be capable of delivering 150% of the design aeration rate.**
5. **The aeration system shall be designed to permit the length of the aeration cycle to be individually adjusted at each pile header pipe.**

(12)~~[(9) Municipal]~~ Sludge Disposal on Land. The program of land spreading of sludge must be evaluated as an integral system which include stabilization, storage, transportation, application, soil, crop and groundwater. ~~[The following guidelines were formulated to provide the criteria of municipal sludge disposal on land. Sewage]~~ Wastewater sludge is useful to crop and soil by providing nutrients and organic matter. **<u>To qualify for land application, biosolids or material derived from sludge or residuals must meet at least the pollutant Ceiling Concentrations, Class B requirements for pathogens and vector attraction reduction requirements in 40 CFR 503.</u>** ~~[Sewage sludge may contains heavy metals and other substances which could affect soil productivity and the quality of food, especially if from industry or from communities with pretreatment programs. Sufficient information is not available to completely evaluate the deleterious effects. The purpose of the guidelines is to indicate the acceptable method of sludge disposal on land surface based on current knowledge. It is recognized that these guidelines should be revised as more information becomes available.]~~

<u>(A) Pre-Land Application Considerations. If a facility wants to land apply biosolids on property they own, lease, or to provide the biosolids to a farmer for application, the facility shall have a biosolids management plan submitted to the Department and shall have the authorization for land application included in their state operating permit.</u>

<u>1. The Biosolids Management Plan shall include:</u>

<u>A. Representative samples are essential to properly evaluate the biosolids or residuals. Analyses which will be of major importance will be for sodium, calcium, magnesium, nitrate, total Kjeldahl nitrogen, pH, phosphorous, potassium, metal ions, boron and fluoride.</u>

<u>B. The initial fields that land application will occur on, with the following information:</u>

1. **<u>Location. A copy of the USGS topographic map of the area, similar map or aerial photograph showing the boundaries of the field and the distance to the property line.</u>**
2. **<u>Legal description of the disposal site;</u>**
3. **<u>The location of all existing and platted residences, commercial or industrial developments, roads, ground or surface water supplies and wells within a quarter (1/4) mile of the proposed site;</u>**
4. **<u>Available land area, both gross and net areas (excluding roads, right-of-way encroachments, stream channels and unusable soils);</u>**
5. **<u>Distance from the wastewater treatment and the storage facilities to the application site;</u>**
6. **<u>Proximity of site to industrial, commercial, residential developments, surface water streams, potable water wells, public use areas such as parks, cemeteries and wildlife sanctuaries;</u>**
7. **<u>Information on existing drainage systems, including information on the subsurface or surface practices, tile drainage, intermittent flows, and practices employed such as capping of inlets;</u>**
8. **<u>The expected life span of the application field based on the application rates and concentrations present in the sludge.</u>**
9. **<u>A description of the suitable barriers restricting access to meet the site restrictions identified in subsection (B)(5) of this rule.</u>**

<u>C. A Geohydrological Evaluation from Missouri Geological Survey to identify streams, sinkholes or other features that may impact the application of biosolids.</u>

<u>D. Identify the required sampling and monitoring frequencies of the biosolids and the soils.</u>

E. Identify who will be land applying the biosolids, if it is the permittee, the owner of the field, or a contract operator. Include contact information for each field including land owner's name, address, and phone number.
F. The percent solids being applied.
G. The application method.
H. The prevailing wind direction. Prevailing wind direction can impact odor complaints and potential concerns if near a populated area.

2. The facility shall submit calculations of loadings and application rates for each field based on the analysis of the biosolids, the properties of the soil and the expected crop uptake.
3. Land application of biosolids shall occur within twenty mile radius of the wastewater treatment facility. Land application proposed greater than twenty (20) miles from the treatment plant may be required to obtain additional state operating permits.
4. The Biosolids Management Plan shall be updated each time a new field is added for application. The facility shall have the Plan available for inspection. The addition of new fields does not require the facility to come in for reauthorization to apply biosolids.

(B) Site Selection Considerations. By proper selection of the biosolids application site, the nuisance potential and public health hazard should be minimized.

1. Soil. Biosolids should not be applied to sites that have less than five feet (5 ft) of soil above bedrock or a groundwater aquifer,
2. Buffer Distances. For Class B Biosolids and for industrial residuals, the following buffers shall be observed:
   A. At least one hundred fifty feet (150') from existing dwellings or public use areas, excluding roads or highways;
   B. At least fifty feet (50') inside the property line;
   C. At least three hundred feet (300') from any sinkhole, losing stream or other structure or physiographic feature that may provide direct connection between the ground water table and the surface;
   D. At least three hundred feet (300') from any existing potable water supply well not located on the property. Adequate protection shall be provided for wells located on the application site; and
   E. One hundred feet (100') to wetlands, ponds, gaining streams (classified or unclassified; perennial or intermittent).
   F. Setback distances shall not be decreased to less than thirty-five feet (35') with an established vegetated buffer. The reduction of setback buffer distances shall include a vegetated buffer and the Biosolids Management Plan shall document the type of vegetated buffer and operational requirements.
3. pH. Biosolids or residuals shall not be applied to sites with a soil pH less than 6.0 or greater than 7.5, based on the salt solution test or less than 6.5 or greater than 8.0, based on the water solution test. Application of biosolids or residuals to higher pH soils may be considered on a case-by-case basis with supporting documentation addressing crop and groundwater protection and the tracking of aluminum loading rates.
4. Slopes. Slopes should be limited to ten percent (10%) and should employ soil conservation practices to reduce erosion per NRCS recommendations. Slopes on fields greater than ten percent (10%) should only have biosolids applied when the site is maintained in grass vegetation with at least eighty percent (80%) ground cover and conservation practices are employed.
5. Site Restrictions. When sizing and selecting land application fields, when the biosolids meets the Class B pathogen reduction requirements, but not Class A, the following site restrictions must be met for each field.
   A. Food crops with harvested parts that touch the biosolids/soil mixture (such as melons, cucumbers, squash, etc.) shall not be harvested for fourteen (14) months after application.
   B. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for twenty (20) months after application if the biosolids and

sludge is not incorporated for at least four (4) months.

C. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 38 months after application if the biosolids and residuals is incorporated in less than four (4) months.

D. Food crops, feed crops, and fiber crops shall not be harvested for thirty (30) days after biosolids and residuals application.

E. Animals shall not graze on a site for thirty (30) days after biosolids or residuals application.

F. Turf shall not be harvested for one (1) year after biosolids or residuals application if the turf is placed on land with a high potential for public exposure or a lawn.

G. Public access to land with high potential for public exposure shall be restricted for one (1) year after biosolids and residuals application.

H. Public access to land with a low potential for public exposure shall be restricted for thirty (30) days after biosolids and residuals application.

6. When identifying land application fields, consideration shall be given for additional land application fields, crop rotation, or other methods of handling if the wastewater treatment plant has nutrient removal as it can increase the amount of nutrients in the biosolids. It may increase the required application sites by three times or more to meet the agronomic rates of application for total nitrogen and total phosphorus.

(C) Loading Considerations. A detailed analysis of the biosolids or residuals shall be made and the application rate shall be based on characteristics of the application site and crop uptake. The proposed application rates shall take into consideration the drainage and permeability of the soils, the distance to the water table and for no observable runoff to occur.

1. Metals. The sizing and loading of the application fields cannot exceed the values listed in Table 170-X: Ceiling Concentrations.

TABLE 170- X: Ceiling Concentration

Pollutant	Milligrams per kilogram dry weight
Arsenic	75
Cadmium	85
Copper	4,300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

2. Total Nitrogen. Nitrogen application rates shall not exceed the amount of nitrogen that can be utilized by the vegetation to be grown.

A. Nitrogen content of the biosolids should not exceed the fifty thousand milligrams per kilogram (50,000 mg/kg) of total nitrogen on a dry weight basis. If exceeding the fifty thousand milligrams per kilogram (50,000 mg/kg) on a dry weight basis or more than one hundred fifty pounds per acre (150 lbs/acre), the plant available nitrogen (PAN) shall be calculated following Equation 170-x and included in the Biosolids Management Plan.

Equation 170-x

PAN=(Nitrate + nitrite nitrogen) + (organic nitrogen x 0.2) + (ammonia nitrogen x volatilization factor)

The volatilization factors are 0.7 for surface application and 1 for subsurface injection.

3. Total Phosphorus. Phosphorus can be present at levels that exceed the crop requirement when applications are based on nitrogen, an agronomic soil test shall be performed as not all of that P is available for crop growth. Phosphorus tests include the Mehlich-3 soil test, the Bray-1 and

the Olson P tests. Application of biosolids shall not exceed eight hundred pounds (800 lbs) of available phosphorus based on the Bray P-1 test. If wanting to apply more than eight hundred pounds (800 lbs), the Biosolids Management Plan shall include the expected total phosphorus loading for approval.

(D) Operations and Maintenance Considerations. The facility shall have an operations and maintenance section in their Biosolids Management Plan or a separate document and have it available. The operations and maintenance sections shall be updated as additional fields are added for application or there is a change in the method of application.

1. The Operations and Maintenance Section should contain the following information on each piece of equipment used on the application site, including any pumps, piping, traveling guns, knifing operations.

2. The operations and maintenance section should contain contact information for each land application field, including owner's name, address, and phone number.

3. The spreading operation shall be covered in the Manual. Considerations for the spreading operations should include:

A. Hauling equipment. The biosolids hauling equipment should be designed to prevent spillage, odor and other public nuisance. Soil compaction should be avoided because compaction restricts plant root growth, which in turn limits plant top growth.

B. Valve control. The spreading tank truck should be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion. The spreading valve should be of the fail-safe type (that is, self-closing) or an additional manual standby valve should be employed to prevent uncontrolled spreading or spillage.

C. Consideration for immediate incorporation of sludge after spreading or subsurface injection to reduce odors and runoff. When such method is utilized, an adjustment in the reduced rate of ammonia loss into the atmosphere should be considered in the computation for nitrogen balance.

4. Emergency Operations shall be included in the Operations Manual. Emergency operations identified in the plan should include additional fields available for land application or the process the permittee will do undertake to obtain additional fields or if the permittee will not land apply. If not land applying the biosolids, the Manual should identify who is willing to accept the biosolids, whether another wastewater treatment facility or a municipal landfill.

~~*[(A) General Limitations to be Observed.*~~

~~*1. Stabilized sludge. Only stabilized sludge shall be surface applied to farmland or pasture. Stabilized sludge is defined as processed sludge in which the organic and bacterial contents of raw sludge are reduced to levels deemed necessary by the agency to prevent nuisance odors and public health hazards. Any process which produces sludge equivalent in quality to the above in terms of public health factors and odor potential may be accepted. Additional treatment would be required to further reduce pathogens when the sludge is to be spread on dairy pastures and other crops which are in the human food chain.*~~

~~*2. Raw vegetables. Sludge should not be applied to land which is used for growing food crops to be eaten raw, such as leafed vegetables and root crops.*~~

~~*3. Minimum pH. No sludge shall be applied on land if the soil pH is less than 6.5 when sludge is applied and pH shall be maintained above 6.5 for at least two (2) years following end of sludge application.*~~

~~*4. Persistent organic chemicals. At present time, sufficient information is not available to establish criteria of sludge spreading in regard to persistent organic chemicals, such as pesticides and polychlorinated biphenyls (PCB). However, if there is a known source in the sewer service area which discharges or discharged in the past such chemicals, the sludge should be analyzed for chemicals and the agency shall be consulted for recommendations concerning sludge spreading.*~~

~~*(B) Site Selection. By proper selection of the sludge application site, the nuisance potential and public health hazard should be minimized. The following items should be considered and the agency should be consulted for specific limits: land ownership information; groundwater table and bedrock location; location of dwellings, road and public access; location of wells, springs, creeks, streams and flood*~~

~~*plains; slope of land surface; soil characteristics; climatological information and periods of ground freezing; land use plan; and road weight restrictions.*~~

~~*(C) Sludge Application on Farmland. Heavy metal loading to land should be limited in order to avoid reduction of soil productivity. A detailed chemical analysis of the sludge shall be made and the application rate shall be based on characteristics of the application site and crop uptake. The agency shall be contacted for specific limits.*~~

~~*(D) Sludge Application on Forested Land. Disposal of sludge on forested land is considerably less hazardous than on cropland in terms of heavy metal toxicity unless the land is to be converted to cropland. For the allowable sludge loading the agency should be consulted.*~~

~~*(E) Management of Spreading Operation.*~~

~~*1. Hauling equipment. The sludge hauling equipment should be designed to prevent spillage, odor and other public nuisance.*~~

~~*2. Valve control. The spreading tank truck should be provided with a control so that the discharge valve can be opened and closed by the driver while the vehicle is in motion. The spreading valve should be of the fail-safe type (that is, self-closing) or an additional manual standby valve should be employed to prevent uncontrolled spreading or spillage.*~~

~~*3. Sludge storage. Sufficient sludge storage capacity shall be provided for periods of inclement weather and equipment failure. The storage facilities shall be designed, located and operated so as to avoid nuisance conditions.*~~

~~*4. Spreading methods. The selection of spreading methods depends on the sludge characteristics, environmental factor and others. When control of odor nuisance and runoff is required, immediate incorporation of sludge after spreading or subsurface injection should be considered. When such method is utilized, an adjustment in the reduced rate of ammonia loss into the atmosphere should be considered in the computation for nitrogen balance. The sewage sludge should be spread uniformly over the surface when tank truck spreading, ridge and furrow irrigation or other methods are used. Proposals for subsurface application of sludge shall include for review a description of the equipment and program for application. Spray systems except for downward directed types will not ordinarily be approved.*~~

~~*5. Boundary demarcation. The boundaries of the site shall be marked (for example, with stakes at corners) so as to avoid confusion regarding the location of the site during the sludge application. The markers should be maintained until the end of the current growing season.*~~

~~*6. Public access. Public access of the disposal site must be controlled by either positive barriers or remoteness of the site.*~~

~~*(F) Monitoring and Reporting. The requirement of the agency on the monitoring and reporting of sludge spreading operation should be followed. As a minimum, the producer of sludge should regularly collect and record information on the sludge and soil characteristics and volume of sludge spread to a particular site.]*~~

~~*[(10)]*~~ **(13)** Other Sludge **or Biosolids** Disposal Methods. When other sludge disposal methods, such as incineration and landfill, are considered**, the permittee shall work with the Department on the appropriate requirements, including the Air Pollution Program and the Solid Waste Management Program to ensure all applicable regulations are followed**. ~~*[pertinent requirements from the agency shall be followed.]*~~